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State & Private Forestry

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Condition of Sugar Maple

1996

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Introduction

During the late 1970s and throughout the 1980s sugarbush managers, foresters and the public became concerned about maple decline. In response to these concerns, the North American Maple Project (NAMP) was formed in 1987 between Canada and the United States and authorized by a Memorandum Of Understanding and Special Project Agreement.

The administration and the financial support for the project is provided by the Canadian Forest Service and Forest Health Protection, Northeastern Area, USDA Forest Service. Participating states and provinces provide field crews and local administration of the project.

The current project is guided by a Joint Management Team co-chaired by Gerard D. Hertel, USDA Forest Service, and J. Peter Hall, Canadian Forest Service. Ten states and four provinces cooperate in the project. National Coordinators provide day-to-day guidance: Bruce Pendrel, Canadian Forest Service, and Robert Cooke, USDA Forest Service. Quality-assurance is a high priority because 14 different agencies collect data. Standardized training is provided by the National Coordinators annually. Remeasurements are done between crews, states and provinces for data quality evaluation by the National Coordinators. Data analysis is provided by Douglas C. Allen and Andrew W. Molloy, State University, College of Environmental Science and Forestry, Syracuse, New York.

Objectives

The objectives of the project are to determine:

1. the rate of change in sugar maple condition.
2. if the rate of change in sugar maple condition is different among:
   a. various levels of sulfate and nitrate wet deposition.

Figure 1. *North American Maple Project stand locations.*

b. sugarbush (SB) and non-sugarbush (NSB) forests.
c. various levels of initial stand decline conditions.

3. possible causes of sugar maple decline and the geographical relationships between potential causes and extent of decline.

Plot Establishment

The total number of plot-clusters monitored and evaluated by NAMP in 1996 was 233 (Table 1). Geographic coverage now extends from Minnesota and Ontario, south to Ohio and Pennsylvania, and east to Nova Scotia (Fig. 1).

Each plot-cluster consists of five plots (20 by 20 m) located in a sugar maple stand that is 50 to 150 years old. In most states and all the provinces, one-half of the plot-clusters are active sugarbushes and one-half are in non-sugarbush stands. Stands were selected to represent a range of initial forest decline conditions and site conditions, and they cover most of the prime sugar maple growing areas.

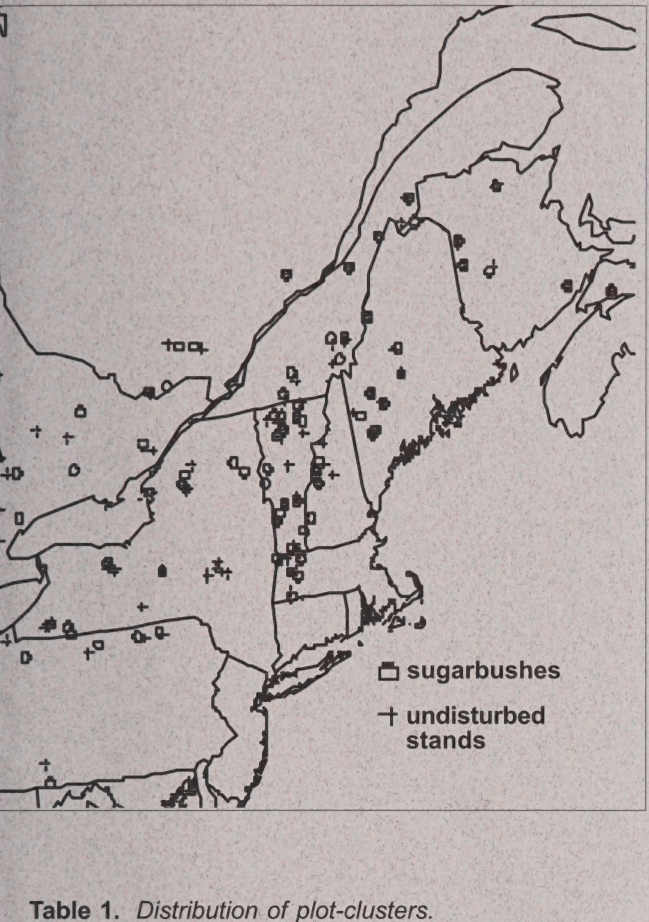

Table 1. *Distribution of plot-clusters.*

United States		Canada	
Maine	18	New Brunswick	12
Massachusetts	10	Nova Scotia	2
Michigan	24	Ontario	24
Minnesota	8	Quebec	24
New Hampshire	10		
New York	27	**Total**	**233**
Ohio	6		
Pennsylvania	10		
Vermont	40		
Wisconsin	18		

Stand Description

In 1996 the average sugarbush in this study had 149 live trees per acre (369 trees/ha), 77% of which were sugar maple, and the average tree diameter at breast height (dbh) was 10.4 in (26.4 cm). The non-sugarbush stands averaged 184 live trees per acre (454

trees/ha), 70% of which were sugar maples, with a slightly smaller average dbh of 9.7 in (24.6 cm). Average basal areas were 111.8 ft^2/ac (25.6 m^2/ha) and 114.5 ft^2 (26.3 m^2/ha) in sugarbush and non-sugarbush stands, respectively.

Observations in 1996 were made on 19,025 live trees, of which 73% are sugar maples. Sixty-six percent of the live sugar maples are in the dominant or codominant crown positions. The other most common species are American beech, basswood, ash, red maple, and yellow birch.

Methods

Sugar maple crowns are evaluated annually for dieback and foliage transparency and visited twice annually to assess insect-caused defoliation. Annual visits are required because the incidence of dieback and transparency are expected to fluctuate from year to year as a result of individual tree response to changes in weather and site conditions. Insect defoliation may occur in both spring and mid-summer, therefore two annual visits are required.

Quality and consistency of data are assured through annual training and certification of field crews. At least 5% of crown ratings are remeasured to assess data quality. Approximately 90% of remeasurements in 1988 fell within the prescribed standards. This repeatability of measurements improved to approximately 95% in 1989 and remained at this level through 1996.

The results presented here are based on analyses of the crown condition of 9,198 live upper canopy (dominant/codominant) sugar maples in 1996. Branch dieback in the upper crown is a symptom caused by various stresses. For this project, 5% dieback is considered normal; 6% to 15% percent indicates moderate damage; and more than 15% dieback indicates a high level of damage. Foliage transparency, a measure of crown density, is estimated by the amount of light penetrating the crown. A transparency of 25% or less is considered normal for sugar maple, 26% to 55% transparency indicates a moderately thin crown, and greater than 55% transparency is considered high. The latter suggests that a tree is severely stressed.

Sugar Maple Conditions in 1996

Dieback

Crown dieback reflects the general, long-term health of individual trees. The average dieback of upper canopy sugar maples in 1996 for all 231 plot-clusters was 7.5% in sugarbushes and 6.8% in non-sugarbushes (Table 2). Over 9 years this average changed by less than 2% for both categories. The highest crown dieback for 1996 was in Wisconsin where sugarbushes averaged 10.5% and non-sugarbushes, 10.1%. Average dieback was greater in sugarbushes compared to non-sugarbushes in 7 of 12 regions. The range of differences was 0% to 1.8%, and none was statistically significant.

Table 2. *Average plot-cluster dieback and transparency of upper canopy sugar maples, 1996*

	Average Dieback (%)		Average Transparency (%)	
Region	**SB**	**NSB**	**SB**	**NSB**
Maine	7.4	5.8	11.9	11.7
Massachusetts	6.0	7.0	12.5	12.6
Michigan	4.5	5.9	10.4	10.0
Minnesota	6.8	6.8	11.2	11.6
New Brunswick/ Nova Scotia	10.3	8.5	13.4	11.8
New Hampshire	4.5	5.0	13.1	12.8
New York	7.3	5.8	11.5	11.7
Ohio	7.9	---	15.4	---
Ontario	8.0	7.6	12.6	11.8
Pennsylvania	6.1	6.2	12.9	13.5
Quebec	8.0	6.4	12.3	11.1
Vermont	7.7	7.2	13.9	12.9
Wisconsin	10.5	10.1	12.1	12.7
All	**7.5**	**6.8**	**12.6**	**11.9**

Figure 2 compares the incidence of high levels of dieback (>15%) between regions using all upper canopy sugar maples in 1996. Wisconsin had the greatest percentage of trees with >15% dieback in sugarbushes and non-sugarbushes (14.9% and 16.5%, respectively). In many regions, minor changes occurred in the proportion of upper canopy sugar maples with >15% crown dieback compared to the previous year. These changes may reflect normal fluctuations in crown condition. Wisconsin displayed the largest increase from 1995 to 1996 (1.3% and 1.2% in 1995 for sugarbushes and non-sugarbushes, respectively). No disturbances were recorded for the Wisconsin plot-clusters which might explain this change. The largest decrease from 1995 to 1996 occurred in New Brunswick/Nova Scotia plot-clusters. This 9% change in the number of trees with high dieback in sugarbushes probably represents the recovery of trees from ice damage caused by widespread freezing rain in early 1995.

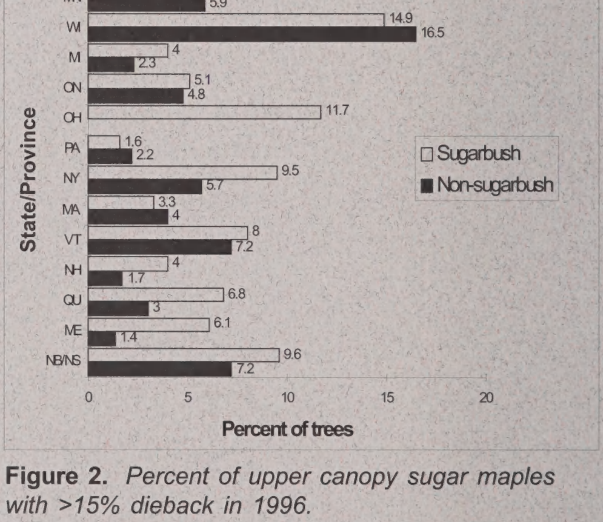

Figure 2. *Percent of upper canopy sugar maples with >15% dieback in 1996.*

Transparency

Crown transparency reflects annual fluctuations in tree condition due to disturbances such as defoliation and drought. The average plot-cluster transparency of upper canopy sugar maples in 1996 was 12.6% in sugarbushes and 11.9% in non-sugarbushes (Table 2). These averages have been fairly consistent since 1990 and are lower than the 1988 and 1989 averages. The average plot-cluster transparency has decreased (improved) by 4.3% to 5.2% in sugarbushes and

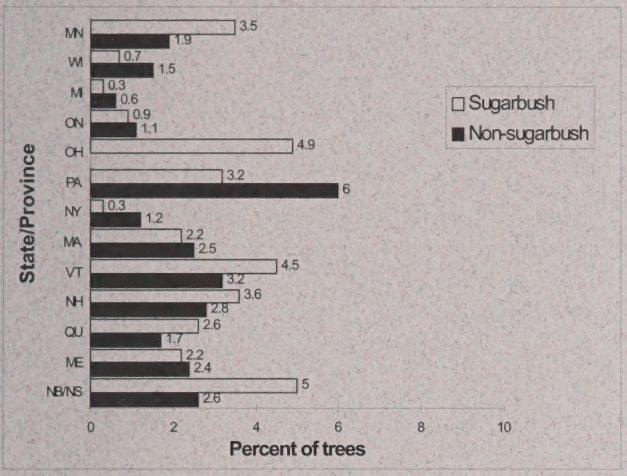

Figure 3. *Percent of upper canopy sugar maples with >25% transparency in 1996.*

non-sugarbushes since 1988. The highest average transparency occurred in Ohio sugarbushes (15.4%). Several Ohio plot-clusters experienced damage due to wind storms in March and April, which may explain the higher levels of transparency. For non-sugarbushes, 10 of 12 regions had transparency levels from 11% to 12%. Vermont was slightly higher with 13.9% average transparency. Average transparency was greater in sugarbushes compared to non-sugarbushes in 7 of 12 regions, although none of the differences was statistically significant.

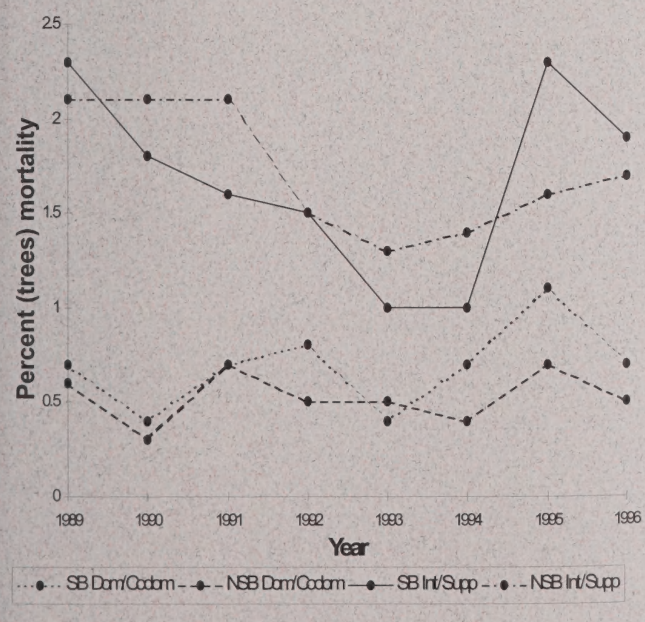

Figure 4. *Percent (trees) mortality for sugar maple (1989-1996)*

No state/province had more than 6% of its trees with >25% transparency (Fig. 3). For sugarbushes, New Brunswick/Nova Scotia had the highest proportion of trees (5%) with >25% transparency. Pennsylvania had the greatest percentage of trees (6%) with >25% transparency in non-sugarbushes. Decreases from 1995 to 1996 of 12.9% to 27% were noted in Pennsylvania and New York plot-clusters. In Pennsylvania, this coincided with much lower defoliator activity compared to previous years. In New York, defoliators were still active in a few plot-clusters, but damage peaked late in the growing season after visitation by field crews.

Mortality

The long-term NAMP data set enables us to determine the annual mortality rate (expressed as a percentage of trees) of sugar maple in the original 165 NAMP plot-clusters. This mortality does not include trees that were healthy when cut as part of a stand management activity or that were killed as a result of management-related practices.

In both the lower canopy and upper canopy there was no consistent difference in mortality between sugarbushes and non-sugarbushes. For six of eight years, however, annual mortality of upper canopy sugar maples in sugarbushes was slightly higher than in non-sugarbushes (Fig. 4). Differences between mortality levels in the upper and lower canopy ranged from 0.3% to 1.1% and from 1.0% to 2.3%, respectively. Sugar maples in lower canopy crown positions are expected to have higher mortality due to competition. Mortality of upper canopy trees in 1996 decreased by 0.2% to 0.4% compared to 1995.

On a state/province level, mortality in sugarbushes was higher compared to non-sugarbushes in 7 of 10 regions but almost identical overall (0.7% vs. 0.6%) (Table 3). The higher upper canopy annual mortality in New York sugarbushes (2.1%) is probably the continued result of severe windstorms in 1995. However, this rate is down from 5.4% in 1995.

Conclusions

Approximately 93% of the sugar maples on all of the NAMP plot-clusters are considered healthy based on an evaluation of crown conditions in 1996.

Table 3. Mortality of upper canopy sugar maples (% trees) in NAMP by region and management type in 1996 and the eight-year average (using the original 165 plot clusters).

Region	Live Trees in 1996	SB %)	NSB %)	Combined Mortality (%) 1996	8-yr. avg.
ME	671	0.9	1.5	1.2	0.8
MA	429	0.0	0.0	0.0	0.3
MI	184	0.0	0.0	0.0	0.6
MN	215	1.6	0.0	0.9	0.6
NB/NS	819	0.4	1.0	0.6	0.4
NH	243	0.6	1.5	0.8	0.6
NY	522	2.1	1.1	1.6	1.2
OH	137	0.0	---	0.0	0.7
ON	876	0.5	0.0	0.2	0.4
PA	169	1.4	1.0	1.2	0.5
QU	1,205	1.4	0.5	0.9	0.8
VT	956	0.4	0.0	0.2	0.6
WI	603	0.3	0.0	0.2	0.3
ALL	**7,029**	**0.7**	**0.6**	**0.6**	**0.6**

The overall condition of sugar maple crowns in stands managed for syrup production was similar to the condition of maple crowns observed in non-sugarbushes.

Most improvements in crown condition between 1988 and 1996 are associated with recovery from damage by pear thrips in Vermont and Massachusetts, forest tent caterpillar and maple webworm in New York, forest tent caterpillar in Ontario, and recovery from severe drought in 1987 through 1989 (1988 was the worst year) in Michigan and Wisconsin. Although crown conditions improved overall, various localized factors have been responsible for annual changes within some regions.

Insect defoliation and severe winds affected sugar maple crown condition and mortality locally in 1996. Insect defoliators appeared to be less active in most regions compared to 1995.

For the project as a whole, mortality of upper canopy sugar maple has averaged 0.6% per year since 1989, and was 0.6% in 1996. This annual mortality is within the normal variation expected as stands develop and age. Lower canopy mortality was 1.8% in 1996 and averaged 1.7% per year for the 8 year period.